The Aero-Mechanical Conveyor

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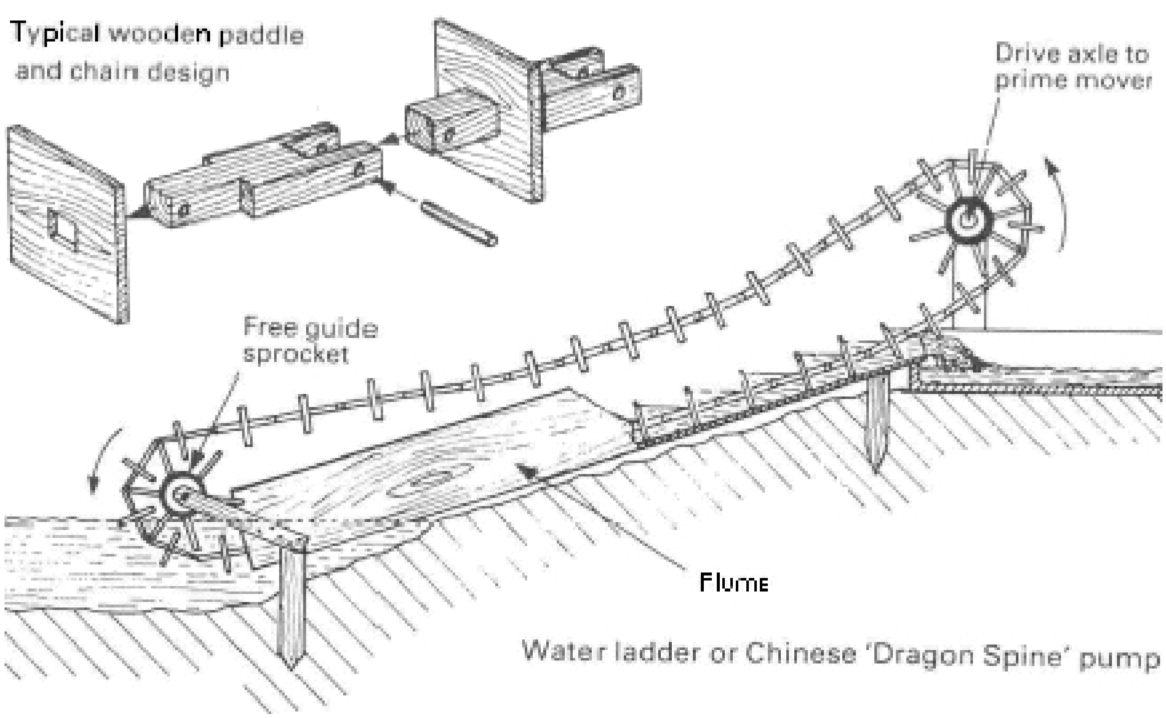
The Aeromechanical Conveyor

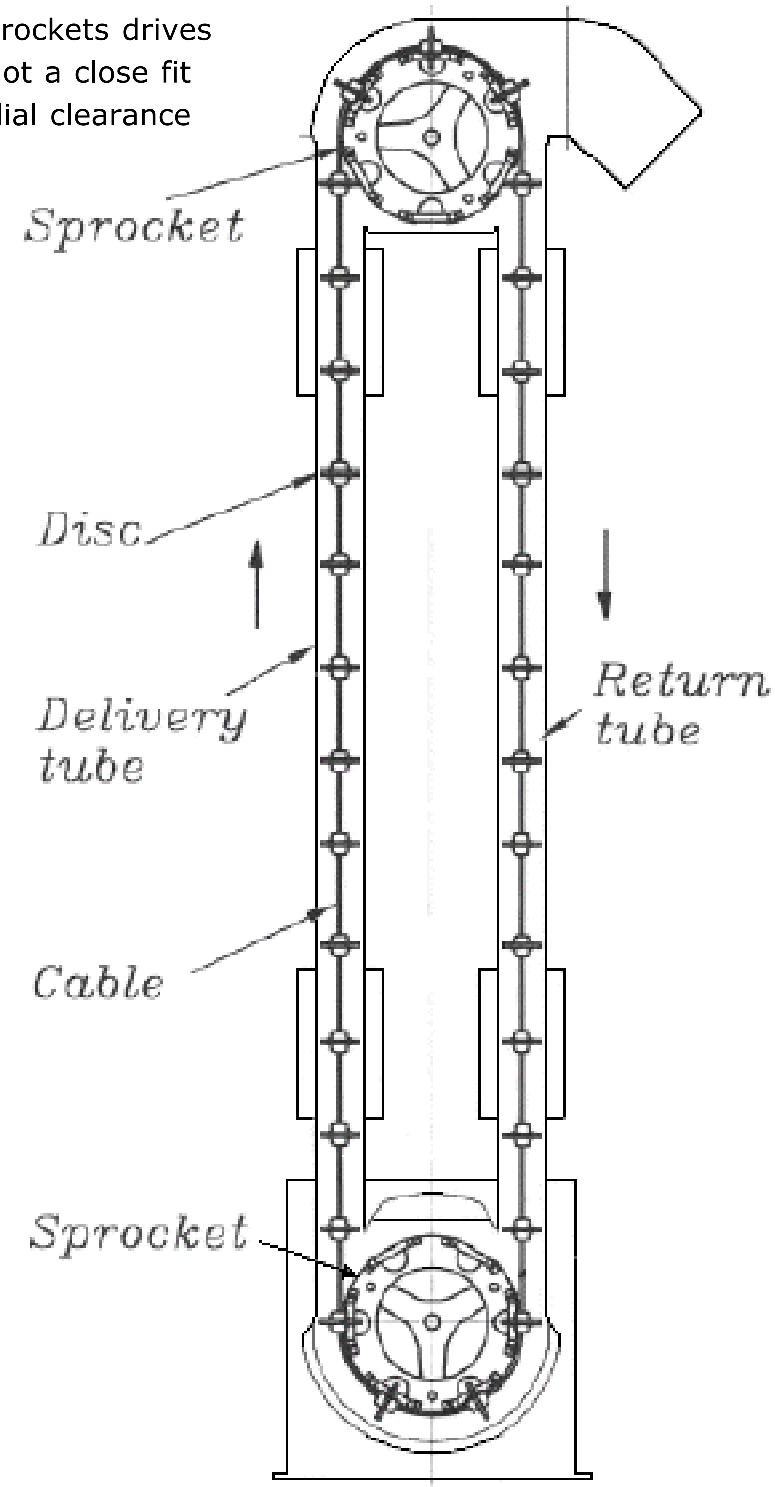
Definitions: What is an aeromechanical conveyor? The name could mean any mechanical conveying device that imparts sufficient turbulence to material being conveyed to cause it to become aerated. Drive a bucket elevator or a screw feeder fast enough and you will aerate whatever gets in the way of the mechanical components. But, for purposes of this brief talk, I will say that an aeromechanical conveyor is "a powder transporting device, consisting of a constant-diameter tube containing a series of discs mounted at fixed intervals on a cable—with a drive mechanism that propels the discs through the tube at a velocity sufficient to cause turbulence within the tube.

Origins: The credit for its invention as a powder conveyor goes to the late Bob Walker of Western Australia, who patented a design in the 1950s. The basic proportions have not changed significantly, although various manufacturers have developed and extended it possibilities.

I like to think that Walker drew his inspiration from ancient "dragon spine" irrigation pumps still to be seen in use in parts of Asia today—although now they are more likely to be driven by an engine, rather than leg power.



Main features: In its simplest form, the aeromechanical conveyor consists of a continuous cable-and-disc assembly, contained within two parallel tubes held by a terminal housing at each end. The cable assembly is mounted on terminal sprockets within the housings, and one of these sprockets drives the conveyor. The discs are not a close fit in the tubes; typically, the radial clearance between disc and tube wall will be 3 to 6 mm.



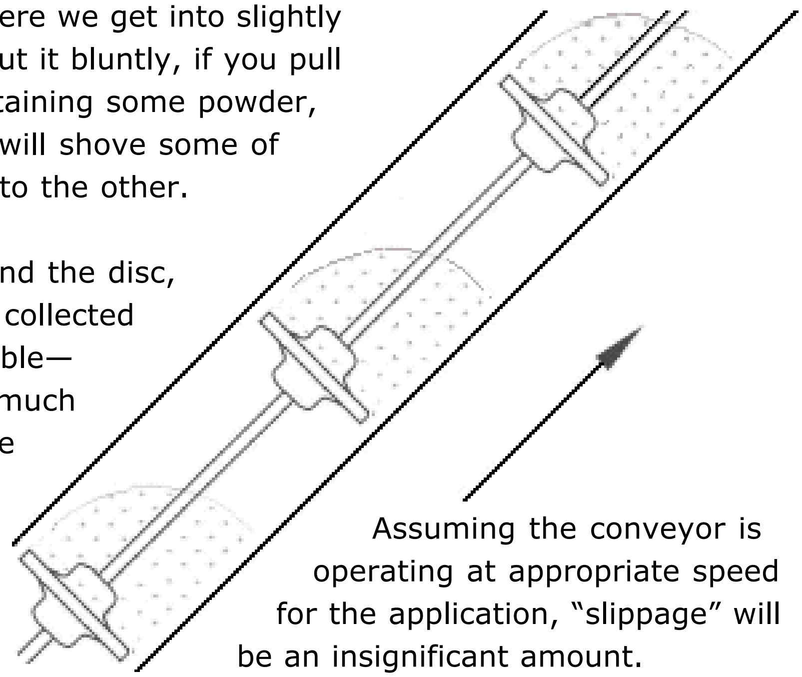
The most common tube diameters are nominally 75 and 100 mm, although there are designs larger and smaller than this.

The velocity required for aeromechanical operation is not fixed by some rigid formula. As a practical guide, it may be said to be between 2 and 4 meters per second.

There is no restriction on the operating angle of the conveyor, which may be anywhere between horizontal and vertical.

One end of the conveyor (usually the discharge end), will incorporate a tension adjustment device for taking up slack in the cable when it becomes extended through use.

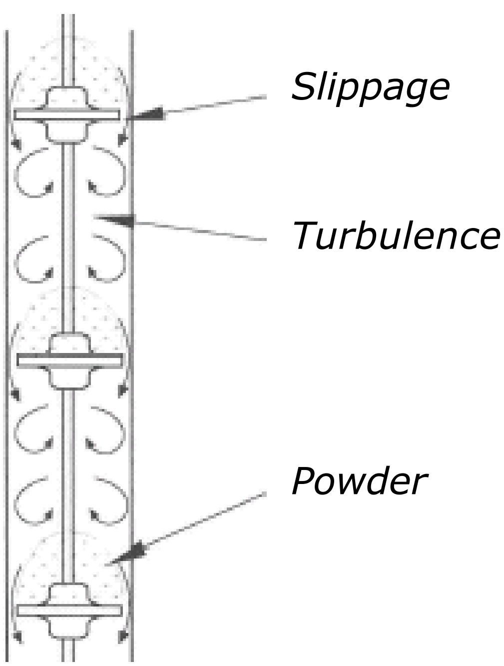
How it works: This is where we get into slightly contentious territory. To put it bluntly, if you pull a disc through a tube containing some powder, chances are that the disc will shove some of the powder from one end to the other.



Due to the clearance around the disc, some powder is left to be collected by the next disc on the cable—and so on. Precisely how much is left is unimportant, since the amount is a constant per unit # of discs, whether the conveyor is 2 or 20 meters long.

Assuming the conveyor is operating at appropriate speed for the application, "slippage" will be an insignificant amount.

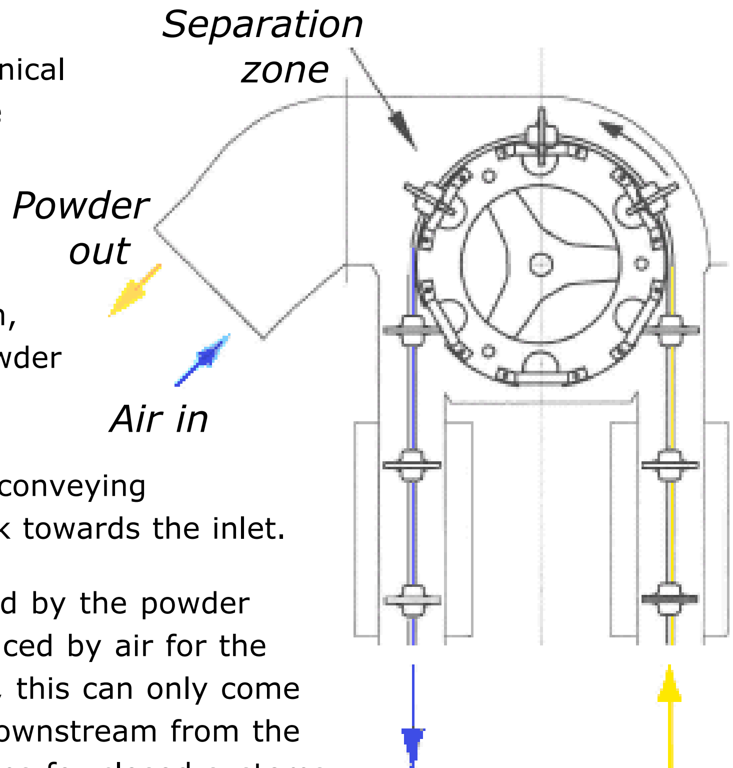
In fact, rather than being a problem, it is a fair assumption that, without slippage, there would be less of the turbulence and aeration of powder on which the conveyor to a large extent depends.



The presence of this small amount of powder swirling around the trailing edge of the disc has given rise to the belief that somehow the powder is being sucked through the conveyor, or held suspended in the columns of air between the discs.

And this may be true for the small constant proportion in constant transit from one disc to the next following—call it the "slippage constant"—but the main bulk of the powder is being propelled mechanically. In short, it is being pushed.

Displacement and separation: Before looking at the aero-mechanical conveyor in a process context, we should note what is happening at the inlet and outlet end of the system.



In a conventional twin-tube design, with centrifugal discharge, the powder takes the exit—while the air that accompanies the powder through the delivery tube must follow the conveying discs into the return tube and back towards the inlet.

But whatever volume was occupied by the powder on the delivery side must be replaced by air for the return trip. As the diagram shows, this can only come from the outlet and whatever is downstream from the outlet. This has obvious implications for closed systems where gases or vapors other than dry ambient air may be present.

The opposite situation prevails at the inlet housing of the aero-mechanical conveyor. The powder must displace air between the discs in order to enter the delivery tube, and this displaced air must have a means of escape. This will usually be through whatever feed system is upstream of the aero-mechanical conveyor. If it is simply a flooded gravity feed, then the displaced air in trying to escape may seriously impede the powder entry. It is not difficult to baffle the inlet zone in such a way that these difficulties are overcome.

Capacities: Having touched upon powder transfer, air displacement and velocities, it's worth putting a few simple numbers on things to see what they tell us. We'll assume that the swept volume of the conveyor is the product of the CSA of the tube and the disc velocity.

Taking a fairly typical shaft speed of 200 rpm on a conveyor with 75 mm diameter tubes, we arrive at a linear velocity of 3 metres/sec—giving us about 720 litres/minute or just about 43 cubic meters per hour.

But aero-mechanical conveyors don't work without space to cause turbulence, and turbulence itself implies a decrease in bulk density.

So if, for the sake of convenience, we assume a halving of bulk density, and a 50% fill capacity between the discs, we have an effective conveying rate of 180 litres/minute. Given a powder with a bulk density of, say, .66 kg/litre, and a typical aeromechanical conveyor length of 6 metres, we will achieve a quite respectable throughput of 120 kg/minute or 7.2 tonnes/hour. And, since our disc velocity is 3 metres/second, residence time within the tube is only 2 seconds and the amount of in-flight material will be no more than 4 kg.

Considerations such as these make the aeromechanical conveyor an attractive choice for a number of applications.

Applications: Apart from the obvious—getting powder from one point to another as cost-effectively as possible—several other objectives may have high priority in particular applications for which the aeromechanical system may claim consideration.

Batch transfer The aeromechanical conveyor will deliver an accurately weighed amount from a batch weigher, or respond quickly to changes on a continuous weigh system. It is not, however suitable as a metering device itself.

Blended powders No separation occurs when transferring powder blends, even when there are considerable variations in density and particle size.

Particle attrition Aeromechanical conveying is not completely damage free; but, as a rule, damage will be much lower than on a screw elevator or lean-phase pneumatic system. It should be noted that fragile agglomerates may be usefully broken up by the aeromechanical conveyor during transit, but hard lumpy material will cause damage to the discs and cable and even the sprockets. The aeromechanical conveyor is definitely not a rock crusher!

Operating angles The aeromechanical conveyor will operate at any angle, although there will be insignificant loss of output when used vertically on heavy, free-flowing powders. Disc wear will also be affected. There is more wear on the disc rim when operating horizontally than when at a steep angle, but other factors will play a more important part in this aspect of the conveyor operation.

Clean in place If we take this to mean simply emptying between batches, there is no problem. However, the aeromechanical conveyor is not easy to clean completely. Some installations have used water or air with some success.

A great deal more might be said about the aero-mechanical conveyor and developments with multiple-path units, mobile conveyors, jacketed tubes for heat transfer—and, in particular, low-speed conveying at low angles, where aeration is reduced in favour of other benefits of aero-mechanical conveying. These, however, are beyond the scope of this brief overview.

Thank you.

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